# A PRELIMINARY INVESTIGATION OF THE NATURAL HISTORY OF THE TIGER FLATHEAD (*NEOPLATYCEPHALUS MACRODON*) ON THE SOUTH-EASTERN AUSTRALIAN COAST. II.

FEEDING HABITS; BREEDING HABITS.

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(Six Text-figures.)

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In 1930 the author spent some time at sea investigating the natural history of the tiger flathead (*Neoplatycephalus macrodon*), the chief food fish of New South Wales, and in 1934 Part I of these preliminary investigations was published (These Proceedings, lix, 1934, 71). The present paper deals with feeding and reproduction. Maps accompanying Part I show the location of the principal trawling grounds along the S.E. Australian coast.

## The Food and Feeding Habits of the Tiger Flathead.

An unexpected obstacle was encountered in the impossibility of obtaining a really large number of guts for examination. As soon as the flathead are taken from the net they are washed in sea-water and packed away in ice without being gutted. This has been more or less standard practice for many years, and has led to the remarkable situation (according to the trawler men) that any gutted flathead is looked upon with suspicion in the markets; the buyers suspect that the fish has been out of water for an extra long time and has been gutted as a safeguard against putrefaction.

The total number of stomachs examined was 657, these being taken over a series of thirteen cruises at monthly intervals, and each cruise of an average length of eight days. In view of this small number, it was considered advisable to make the investigation a more or less qualitative one, and the results obtained are set forth below.

The outstanding anatomical features of the tiger flathead are the dorso-ventrally compressed body with powerful fins, the exceedingly wide gape of the mouth with strong recurved "canine" teeth on the premaxillae, vomer and palatines, and the large stomach with thick muscular walls; all of these features have a close relationship to the feeding habits of the fish, but a rather surprising feature was the discovery that the flathead is more of a mid-water feeder than was previously suspected, and may at times even approach the surface.

Whilst the flathead must spend a considerable time on the bottom, there is much evidence to show that there is a periodical migration towards the surface which puts them beyond the range of the otter trawl, so that over a given time there may be marked fluctuation in the size of the hauls. The writer had often been told about this "take-off after dark", and in the course of numerous cruises was able to confirm the fact. It has apparently been a common experience from the beginning of the industry, and a search through the early records reveals repeated mention by the skippers, of the sudden decline of catches with the approach of night, and their return to normal the following morning. The example given below is from the records of the trawler "*Brolga*", for September, 1922:

Haul No. 10, time shot, 9 a.m., catch, 8,000 lb.—No. 11, 2 p.m., 6,000 lb.—No. 12, 6.30 p.m., 1,900 lb.—No. 13, 11.30 p.m., 1,400 lb.—No. 14, 4.30 a.m., 7,500 lb.—No. 15, 9 a.m., 5,700 lb.

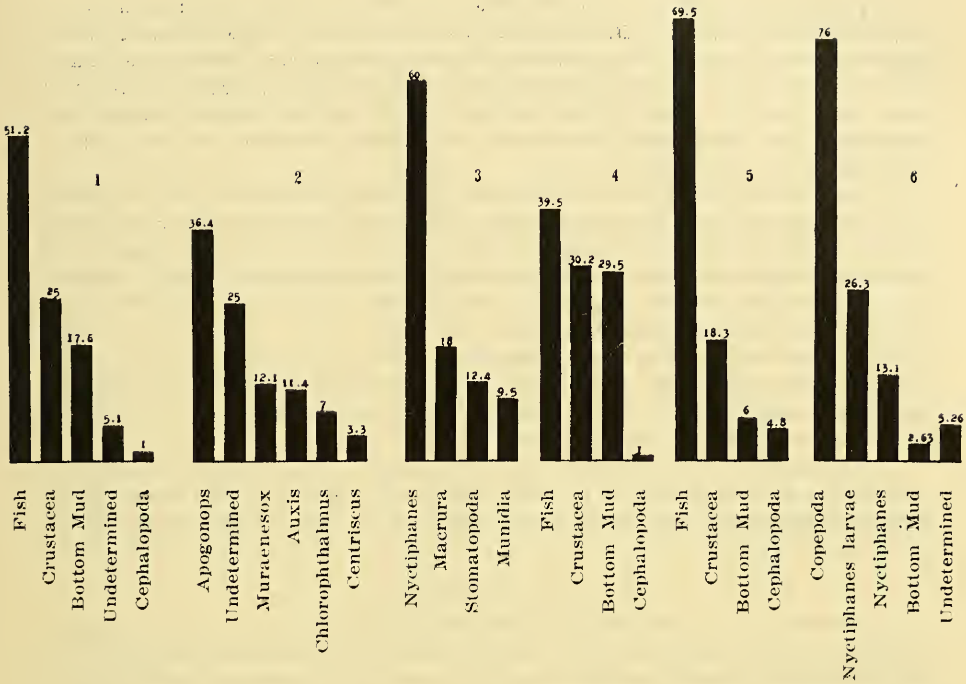
It became more or less a general thing for the boats to fish up till about 7 p.m., and then cease operations until the following morning, yet one must point out that heavy catches of flathead have been taken at night on occasions, which indicates that the fish do not always leave the bottom. There is a further possibility that the poor night fishing was due to a scattering of the shoals, an occurrence which is noticed with other species, but, as will be seen later, the food types eaten by the flathead favour the idea of a vertical migration. They prey extensively on the Euphausid *Nyctiphanes australis*, for instance, and the stomachs of even the largest individuals (i.e., up to 65 cm.) are frequently found distended with this small crustacean; furthermore, some of the remaining food types are mid-water or even surface forms.

In view of the small number of guts available, no attempt at an extensive separation into size classes was made, and a rough grouping was adopted, of "fish above 40 cm.", and "fish below 40 cm.". As the work proceeded, it became clear that a less arbitrary classification was afforded by "above 30–35 cm.", and "below 30–35 cm.", for at that size a considerable change of diet occurs, and also the female attains sexual maturity (at least, a 30 cm. female is the smallest mature fish we found).

Gut samples were taken on each cruise over a period of some fifteen months and, as they came from practically every fishing ground along the coast, may claim to give a fair qualitative representation of the food of the tiger flathead. It has not been considered necessary to publish the details of the contents of the separate guts, or even of the batches of samples from each cruise, and the results given below are a general analysis of the whole series.

Figure 1 gives the proportions of the food types for all sizes of flathead. The most common constituent is fish (51·2%), followed by crustaceans (25%). In 17·6% of the total number there was a varying quantity of "bottom mud", suggesting that the flathead may include bottom-living worms and other organisms which live with their bodies partially buried in the sand. The "mud" was found predominantly in the smaller sizes of fish. For the rest, 5·1% of the material was unidentifiable on account of advanced digestion, and 1% was represented by molluscs (small cephalopods).

Figure 2 shows the proportions of the different fish species found in the stomachs, whilst Figure 3 gives similar data for the crustaceans; in both Figures one particular species is seen to predominate over all the rest. The fish types consumed are not very numerous, and are apparently the most common acceptable members of the flathead's environment. They are as follows: *Apogonops anomalus* (called "Flathead Feed" by the fishermen), *Chlorophthalmus nigripinnis* (Cucumber Fish), *Auxis thazard* (Frigate Mackerel), *Muraenesox cinereus* (Silver Eel), *Trachichthodes affinis* (Nannygai), *Lepidotrigla mulhalli* (Mulhall's Gurnard or Cock Gurnard), *Macrorhamphosus elevatus* (Bellows Fish). The crustaceans are: *Nyctiphanes australis* (Euphausiacea—the so-called "Whale Feed"), *Munidia subrugosa* (Anomura), *Squilla laevis* (Stomatopoda), and an unidentified macruran shrimp.




Figs. 1-6.—Showing the proportions of (1) food-types consumed by the Tiger Flathead, (2) fish species in the food of the Tiger Flathead, (3) crustacean species in the food of the Tiger Flathead, (4) food-types for Tiger Flathead below 35 cm. in length, (5) food-types for Tiger Flathead above 35 cm. in length, and (6) food-types consumed by *Apogonops anomalus*.

Of the fish, *Apogonops* heads the list with 36·4%. It is quite a small fish, seldom exceeding five inches in length, and the specimens which came aboard in the otter trawl were generally 3–4 inches; they must have been very numerous at times, for, in spite of the exceedingly wide mesh of the net, many hundreds would be caught at a time. In addition to the other fish species shown in the figure, one specimen of the Nannygai (*Trachichthodes affinis*) and one of Mulhall's Gurnard (*Lepidotrigla mulhalli*) were taken.

The table for Crustacea (Fig. 3) shows that there is a marked predominance of *Nyctiphanes* (60%), as compared with the remaining species.

Figures 5 and 4 show respectively the food types for flathead above 40 cm., and below 40 cm. As already indicated, it was later discovered that a more significant grouping would have been "above 35 cm." and "below 35 cm.", and accordingly, the majority of individuals included in the first-mentioned exceeded 35 cm., whilst the individuals in the second group did not exceed a length of 35 cm.

In the latter group (Fig. 4) fish predominate (39·5%); next come Crustacea (30·2%), followed by "bottom mud" (29·5%). These results are in great contrast with those shown in Fig. 5, in which fish form 69·5% of the total, Crustacea only 18·3%, and "bottom mud" and cephalopods 6% and 4·8% respectively.

*Nyctiphanes*, as usual, is the commonest crustacean, and is preyed upon by the largest sizes of flathead. "Bottom mud" was found only in the stomachs of the smaller members of the group. These two figures show very clearly the change in diet which occurs as the flathead become larger, viz., a gradual forsaking of other food types in favour of fish; at least, in the present meagre state of our knowledge, that assumption appears to be justified, although it may require modification as work proceeds.

It would appear from these results that the larger flathead are less dependent on the bottom for their food supply, and tend to seek their prey elsewhere. The smaller flathead eat the same kinds of fish as the larger ones, but naturally the prey is of smaller average size, and not so many are swallowed at a time. Furthermore, the smaller flathead appeared to feed more frequently on the Silver Eel (*Muraenesox*) than did the larger ones.

The crustaceans, apart from *Nyctiphanes*, were generally of large size, more especially the stomatopods, which were up to four inches in length. *Nyctiphanes* apparently made up for its small size by its extreme abundance at the period of its maximum occurrence (early spring).

Unfortunately a very important link is missing in this work, in that the otter trawl did not capture any of the very small flathead, i.e., 1 cm.–15 cm., either because of the large mesh, or because these sizes are not normally found on the trawling grounds.

### *The Food of* Apogonops.

*Apogonops* is the most important flathead food-type, and it is quite common for them to come up in the trawl, either because they were near the bottom, or because the trawl passed through a shoal of them as it was being hauled. A batch of 50 stomachs from the Newcastle Ground (see Text-fig. 2A, Proc. Linn. Soc. N.S.W., lix, 1934, p. 73) were examined and, with the exception of fourteen, contained varying amounts of planktonic material; of the fourteen, twelve were empty, and two contained "bottom mud", one of these containing also a small lygaeid hemipteran (Insecta). Of the 38 stomachs containing food, copepods were present in 29, *Nyctiphanes* larvae in 10, adult *Nyctiphanes* in 5, bottom mud in 2, and unrecognizable crustacean debris in 2. The relative proportions of the different food-types are shown in Figure 6, and it is seen that copepods come first (76%), followed by *Nyctiphanes* larvae (26·3%), *Nyctiphanes* (13·1%), with a still smaller percentage of "bottom mud", and unrecognizable debris.

In all, 374 copepods were counted; of these it was possible to identify 330, the balance being too far digested to permit of recognition. No less than 302 of the identified copepods were *Calanus brevicornis*, an interesting sidelight on the relative abundance of this form at the time. *C. brevicornis* is one of the larger copepods, attaining a length of 2·85 mm., and at times has been very plentiful in our plankton catches from the Sydney Heads Station, and from localities further north. The remaining 28 copepods were all medium to large in size, and ten of them were *Calanus minor*, another of our common copepod species. The following is a complete list of the species of Copepoda taken from the *Apogonops* stomachs: *Calanus brevicornis* (302), *C. minor* (10), *C. patagoniensis* (3), *C. tenuicornis* (2), *C. finmarchicus* (2), *Clausocalanus arcuicornis* (3), *Eucalanus attenuatus* (1), *E. elongatus* (1), *Rhincalanus nasutus* (1), *R. cornutus* (1), *Candace pectinata* (1), *C. bipinnata* (2), *Heterochaeta papilligera* (1). *Heterochaeta papilligera* had never been taken by us before, even in the plankton net.

The highest number of copepods identified from one stomach was 61, but the actual number would be slightly higher than this on account of the destruction of some individuals by digestion. A stomach from an 11 cm. *Apogonops*, fully distended by Euphausid debris, had a volume of approximately 1·2 c.c. (external measurements). This is the greatest volume so far noticed.

These results furnish interesting information with regard not only to *Apogonops*, but to the tiger flathead as well, although again not sufficient to justify a really definite statement. *Apogonops* has been shown to be a planktonic feeder in part, and this suggests that the flathead may pursue them into the upper layers of the water. If this is so, i.e., if the flathead are largely mid-water feeders, then the oft-repeated assertion that the present scarcity of flathead is due to destruction of the feeding grounds by the otter trawl, loses some of its force. In the early days of the industry the otter boards were shackled directly to the wings of the net, but the gear in its modern form has undergone considerable modification, in that fifty fathoms of very heavy steel warp are now interposed between net and boards. This means that a much greater extent of sea bottom is covered in a given time, and this factor is blamed for the much reduced hauls obtained during the past few years.

If this blame is justified, it is more probable that the bad effect is due to a general disturbance of the bottom rather than a destruction of feeding areas, and in any case a falling fishery is usually due to a very complex set of factors, no one of which alone could be entirely responsible for the reduction.

### *Other Factors Related to Feeding.*

*Food and Size Distribution.*—The smaller sizes of flathead tended to occur in the shallow water near the coast, and hauls made in the deeper water provided individuals of a larger average size. This was particularly evident in the Eden area, where the grounds commence in thirty fathoms of water quite near the coast and extend out to sea for a considerable distance, the depth reaching 80 fathoms and more. Here, hauls made close inshore gave a predominance of small individuals, i.e., up to about 35 cm., whilst in the deeper water the average size was much greater. There is a marked difference in the bottom fauna in these two areas, for inshore there is an exceedingly abundant growth of large sponges, coelenterates, and polyzoans, and a very rich assemblage of molluscs, worms and crustaceans, thus presumably providing a very favourable feeding ground for the small flathead; on the other hand, the deeper waters appear to have a much less abundant bottom fauna, but if, as has been suggested, the larger flathead are only partially dependent on the bottom fauna for their food, then they would not be affected. Once again it must be stressed that this is an isolated case, and that many other factors must play their part.

The tiger flathead, small or large, is a voracious feeder, and at times engulfs enormous quantities of food. On one occasion the stomach of a 46 cm. flathead yielded a Silver Eel (*Muraenesox*) 42 cm. in length and approximately 2 cm. in cross section. The stomach walls were stretched to such an extent that they were quite translucent. At other times the stomachs have been tightly packed with either *Apogonops* or *Nyctiphanes*, and were many times their original size.

*Parasites.*—The tiger flathead is abundantly parasitized in the stomach region by a small nematode which not only hangs freely from the outer surface as masses of "ringlets", but is massed in the thickness of the walls as well. In the stomachs of the smaller fish were found numbers of a small trematode with a very short sub-cylindrical body and a prominent ventral sucker. One 25 cm. fish yielded no less than thirty of these trematodes from between the folds of the mucous membrane. This restriction of the parasites to the smaller fish was very marked, the usual number found in each individual being 8–14, whilst it was rare to find more than one or two in flathead above 40 cm. In all positions in the body cavity were found specimens of a trematode with a yellowish cylindrical body up to 5 cm. in length. These parasites have not yet been identified as to systematic position.

### Reproductive Organs and the Breeding Season.

This record is also essentially preliminary. The same ground was seldom visited twice in succession (monthly intervals), and it was not possible to secure a really large number of flathead each trip for dissection purposes. Dissection was necessary in all but mature individuals, in order to determine the sex, for the tiger flathead has no externally visible sexual dimorphism; in the case of ripe or nearly ripe fish there was usually some extrusion of reproductive products through the cloaca. It was in this work that one felt the need for a team of workers going out every trip throughout the year, instead of one individual at monthly intervals.

#### *Breeding Season.*

The first definite indication of this period occurs in September, although as early as July the ovaries show signs of development. In July, 1930, good hauls of large flathead were made on the New Zealand ground, and showed well developed ovaries. Although actually very immature from the viewpoint of breeding, these fish were spoken of by the fishermen as "full-roed"; indeed the writer found that few, if any, of them had actually ever seen a really ripe ovary with transparent ova, and they were surprised to learn that the roe could be very large without necessarily being "ripe". On this cruise similar flathead were taken in the Watta Mooli–Botany area.

Five weeks later, during August, 1930, the Pines–Tollgates ground was worked and the average size of the trawled fish was very small. A few large individuals were taken in each haul, and showed large but immature ovaries. Towards the close of this cruise the New Zealand ground was again visited, and the fish were found to be in a similar state of development to those taken on the previous cruise.

Cruise No. 7 took place in late September, and operations were concentrated on the strip of coastline extending from Bateman's Bay to Montagu Is., which thus corresponded largely with the ground worked on the previous cruise. As already mentioned, the average size had been very small on that occasion, but now the flathead were all on the large side, and showed well-developed ovaries. Some individuals, particularly those from the vicinity of Montagu Is., were very large indeed, 56 cm. specimens being quite common, and one 61 cm. female was taken; the ovaries of this fish were so large that they extended to the anterior limits of the body cavity, and caused considerable displacement of the other viscera. Another striking point about the hauls made in this area was the prevalence of large ripe or partially ripe males; in the past most of the males encountered had been very small and individuals of more than 50 cm. were rare. On this occasion, however, the size approached that of the females and the enormous testes occupied most of the body cavity.

The Watta Mooli–Botany ground was also worked at the close of this trip, and yielded flathead of very small average size; in fact, many of them were below the limits prescribed by the law, and had to be thrown overboard. On this ground a

30 cm. female with partially ripe ovaries was taken, and to date this is the smallest size known to us at which sexual maturity is reached.

Cruise No. 8, in November, 1930, was to the Newcastle–Port Stephens area, a ground which is regularly visited by the boats at this time of the year. The flathead taken on the Newcastle ground were remarkable for their large size, soft, easily damaged flesh, and poor keeping qualities as compared with the southern fish; there appears to be here a fruitful field for racial investigations, for even allowing for specialized physiological condition during the breeding season, it is a curious fact that the southern fish of equal size, and at a corresponding period, do not exhibit this remarkable softness and inferior keeping qualities.

On this Newcastle ground large males and females were taken, the biggest of the former just exceeding 54 cm., and of the latter the longest individual was 64 centimetres. These figures are the upper limits of size for the respective sexes so far encountered, and suggest the possibility of a size dimorphism in the two sexes. It has been our constant experience to find a predominance of females in the larger sizes, and the largest male taken was 10 cm. less than the largest female, in all the thousands of fish examined from many different areas; at the lower end of the scale, the smallest sexually-mature male was approximately 10 cm. shorter than the smallest sexually-mature female, the respective figures being 23 cm. and 30 cm. If the males and females do actually grow at different rates, then any scheme of age determination which is based on growth rates will be complicated considerably.

The gonads of these Newcastle flathead were very advanced in development; many ovaries were already showing a few transparent ova, and their general condition suggested that full maturity would be reached in a very short time. On this cruise three thousand fish were tested for ripeness, and of these only one small female proved to be fully so; it was, unfortunately, in such a damaged condition after leaving the net that it was useless for artificial insemination purposes. Spent females were also extremely rare, and no more than six were seen, the general impression being that whilst many of the flathead had commenced to shed their eggs, the majority still had to carry out that process.

The ninth cruise was on the southern grounds, Montagu Is., Watta Mooli, and the New Zealand ground being visited. At Montagu Is. the outstanding feature of the hauls was the large number of small fish taken, and of these the majority were males; in one batch of 75 small flathead dissected, no less than 50 were males, of an average length of 25 cm., most being sexually mature. Many very large females were also taken, and two of the number examined were quite ripe. At Watta Mooli the flathead were large but immature, whilst on the New Zealand ground small immature flathead were taken.

On the tenth cruise (Jan., 1931), the Eden–Green Cape area was again visited, and maturing flathead were very much in evidence. Many of the females had masses of transparent ova, although only one really mature individual was secured. As compared with the previous cruise to grounds a little further north, males were comparatively scarce, comprising only 21% of the total number of fish examined.

The eleventh cruise was to the same area, and the outstanding feature was the decrease in average size, large maturing individuals being relatively few in number. This was even more marked on the twelfth cruise, in April, 1931, to the New Zealand and Jervis Bay grounds, for large fish were not plentiful, and none had mature gonads. Some spent females were taken, and in the smaller size classes there was a decided preponderance of males (61%).

From the foregoing rather disjointed record it appears possible to draw the following general conclusions. The first definite signs of the breeding period occur in early spring, i.e., in September, when the gonads of the females begin to show marked increase in size. On the northern grounds, i.e., at Newcastle, in the month of October, there is an influx of very large flathead which would shed their ova towards the end of the month and perhaps in the early part of November. After this they disappeared, for the fishery had fallen off so much by early November that the boats returned to the southern grounds, where maturing females were very much in evidence, although very few really ripe females were seen. By March (early) there were definite signs of the cessation of the breeding season, and this was more marked in April. The breeding season for the tiger flathead may then be tentatively said to extend over a period of about four months, commencing (as far as oviposition is concerned) in October, and extending into perhaps the late part of February; apart from this, the northern fish seem to breed sooner than the southern ones and finish by about the middle of December.

One curious experience during these cruises was the great scarcity of really ripe females, for not more than a half-dozen were seen during the whole time the writer spent at sea; in this regard it may also be mentioned that spent females were almost as scarce. Many thousands of flathead passed through our hands in this period, not very many of them having even a few transparent ova in their gonads; thus we do not yet know where the flathead actually go for the final act of oviposition—whether they come close inshore where the trawlers cannot shoot their nets, or whether they rise to the surface. Furthermore, we do not yet know where they go immediately after oviposition, for, as indicated above, spent females were also very seldom seen in the large hauls that came up in the otter trawl.

There is, however, one well-established fact with regard to the movements of the tiger flathead at the time of breeding, and that is a migration from some place, at present unknown, into the waters embraced by the present fishing grounds; the shoals are largely made up of maturing females of large size, accompanied by mature males which are not quite so large as the females. It seems feasible that this migration is an east–west one, and appears to take place sooner on the northern grounds than on the southern.

### *The Number of Eggs Produced.*

In this computation a portion of the mature ovary was weighed, the number of ova contained therein counted, and then, from the total weight of the ovary, it was possible to estimate the approximate number of eggs produced. The highest return from a number of ovaries was two and a half million. The testes of the largest males easily equalled the largest ovaries in size and must produce enormous numbers of sperm.

### *Experiments in Artificial Insemination.*

Several attempts were made to obtain the very earliest developmental stages of the fertilized eggs, but all of these were unsuccessful; the outstanding difficulty was the acquisition of suitable material in the form of sexually-mature individuals, for, as already indicated, not more than a half-dozen really ripe females were seen, and all of these were dead when taken. Nevertheless, ova taken from them floated when placed in sea-water and, after insemination, appeared to be quite healthy; on the two occasions that experiments had reached this stage, violent gales were experienced, which not only upset the apparatus, but carried away a good deal of the trawler's equipment as well.

At the suggestion of Professor W. J. Dakin, celluloid "cages" were made to hold the fertilized eggs and to facilitate subsequent handling, e.g., removal of samples at intervals for preservation. These cages, the construction of which is described below, were allowed to float about in the large container of sea-water, and each one sheltered about two hundred eggs. It was found unnecessary to suspend the cage in order to keep it in an upright position, for it floated about half-submerged.

The construction of the cage is a very simple matter. The cylindrical body is 6 inches high and three inches in diameter, and is made from sheet celluloid about $\frac{1}{32}''$ in thickness; it has a series of small windows, each one inch square, which are covered with coarse bolting silk. The bottom is a plain circle of celluloid cut to a tight push fit in the body, and also has a large silk-covered window cut in it. The top of the cylinder is closed by a square of bolting silk which is held in position by a band of celluloid which is slipped over the outside.

In making the cage a rectangular sheet of celluloid of suitable dimensions is marked out for the positions of the windows. These lines are deeply scored with a sharp-pointed instrument, and the small squares will break out easily if the celluloid is bent away from the score; it is useful to remember that this is the correct method for cutting celluloid, which does not respond nearly so readily to scissors. When all of the window spaces have been formed, the sheet is bent around to form a cylinder, with the edges overlapping a little, the latter being first smeared with a fairly strong solution of celluloid in amyl acetate and acetone (equal parts). The seam is then clamped between two pieces of wood until the celluloid solution has set. This does not take more than three or four hours, and the bottom can then be fastened in position by slipping it into the body and running a line of the celluloid cement around the junction of the two; this, too, will set very quickly into a thin, tough fillet of celluloid. Small squares of bolting silk are now stuck over the windows with the same type of cement, applied by means of a soft brush, and when these have dried the cage is immersed in changes of sea-water for several days in order to "season" it, and remove all traces of any harmful chemicals.

For the main sea-water container, a large galvanized bucket was used, holding about five gallons, and was provided with a tap at the bottom to facilitate the drawing off of used sea-water. This bucket, too, was submitted to prolonged soaking in changes of sea-water before using.

*Summary.*

Certain qualitative aspects of the food and feeding habits of the tiger flathead, as well as the question of reproduction, are discussed.

*Food.*—The feeding activities of the specimens examined are shown to be confined to a few forms, all of which occur abundantly in the flathead's environment. These food-types are principally either fish (5 species) or crustaceans (4 sp.), and in each case one species predominates; of the fish it is the small teleost *Apogonops anomalus*, and of the crustaceans the euphausid *Nyctiphanes australis*. Tables are given to show the relative proportions of the different food-types, and emphasize the fact that the tiger flathead is markedly a fish feeder. It is also shown that a change of feeding habits occurs as the flathead grow older, this being in the direction of an increased amount of fish in the diet, and it is suggested that this may be partly due to increased catching power. Closely connected with this is the fact that the larger sizes of flathead become less dependent on the bottom fauna for their food supply, and tend to become mid-water feeders, an interesting

discovery in view of the fact that there has been a tendency to regard the flathead as a typical bottom-frequenting form.

The food of the flathead's chief fish-food type (*Apogonops anomalus*) is also described, and shown to be almost entirely planktonic—large copepods, *Nyctiphanes*, crustacean larvae, etc., although *Apogonops* appears to feed occasionally on the bottom.

*Reproduction.*—The breeding season of the tiger flathead commences in the early spring and extends almost to the end of summer; this observation is based on periodical examination of the reproductive organs, but it is not yet possible to say where oviposition actually takes place because only about a half-dozen really ripe females were seen among thousands of fish examined, and spent females were also scarce. This presumably indicates that the flathead were not spawning on the actual fishing grounds.

Observations show that the northern flathead spawn sooner than the southern ones, the spawning period in the north terminating about the middle of December.

The tiger flathead produces up to two and a half million eggs in one season, although this number would be considerably smaller in the smaller flathead.

A description is given of the construction of a celluloid "cage" for holding fish eggs after artificial insemination, this being the type actually used by the writer.

In conclusion, the writer would like to stress the vital importance of continuing and amplifying this work; the present investigation merely skims the surface and gives a clearer idea of the problems facing future workers.